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quarterly report:

WARHEAD STUDIES

FOR THE PERIOD ENDING 30 JUNE 1967

EXPLOSIVE LENS WARHEAD (U)

An Independent Exploratory Development Progress Report

R. L. HIGUERA
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FUZE DEPARTMENT

NAVAL ORDNANCE LABORATORY CORONA
CORONA, CALIFORNIA

NAVAL ORDNANCE LABORATORY CORONA

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Commanding Officer

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FOREWORD

Exploratory studies on warheads are currently being concentrated on an aimable explosive "fisheye lens" warhead. These studies are authorized under Project ZF009-98-01.

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ABSTRACT

Twenty spherical explosive lens charges have been fabricated, of which 10 have been sent to Sandia Corporation, where tests will be conducted. Flash X-ray photographic equipment will be employed. Ten more are undergoing tests at New Mexico Institute of Mining and Technology to determine their gas profiles and damage-producing capabilities. Results of a comparison test of a homogeneous spherical charge and a spherical lens charge are reported. (U)

Techniques for, and problems concerning, fabrication of cylindrical fisheye lens charges are discussed. (U)

1. BACKGROUND

The independent exploratory development work on warheads at the Naval Weapons Center Corona Laboratories (NWCCL), formerly the Naval Ordnance Laboratory Corona, is currently concerned with the aimable explosive "fisheye lens" warhead.

In March 1965, R. L. Conger of the Research Department described the concept (Ref. 1). He postulated that in somewhat the same manner that light can be focused by an optical lens, a warhead could be focused to aim in virtually any direction by firing a detonator on the opposite side of the warhead from the desired direction of aim. If a warhead were constructed with its explosive compositions in the right arrangement, detonation waves from the firing of the detonator would fire all the explosives in the warhead in such a manner that the detonation fronts would converge and focus at the opposite side of the warhead, thus propelling intense jets of the products of detonation in the desired direction of aim.

Tests conducted by the Research Department verified Dr. Conger's theory (Ref. 2), and preliminary studies were made on both spherical-lens and cylindrical-lens warhead configurations (Refs. 3 and 4).

In the fall of 1965 independent exploratory development funds were allocated to the Fuze Department for investigating aimable warheads. Special instrumentation was set up, and progress on testing the parameters of explosive fisheye lens warheads was reported in the spring of 1966 (Ref. 5). Ways of increasing pattern density were then studied, but further firings were delayed until more suitable charges were available.

Arrangements for the fabrication of improved explosive lens charges were made with the Naval Weapons Center, China Lake, California (NWC China Lake), formerly the Naval Ordnance Test Station, and with the Pantex plant of Mason & Hanger—Silas Mason Company, Amarillo, Texas. NWC China Lake was to fabricate 20 cylindrical charges; Pantex, 20 spherical charges.

By the beginning of this reporting period, Pantex had completed machining ten spherical charges with a 6.2 in. outside diameter and ten with a 7.8 in. outside diameter. Table 1 gives the actual dimensions of the loaded spherical sections, the explosive formulations, and the relative velocities.

TABLE 1. Diameters and Detonation Velocities of the Spherical Charge Sections

Spheres	Explosive	Velocity (m/s)	Diameter of Each Sphere (in.)			
			6.2 in. Charge		7.8 in. Charge	
			Inside	Outside	Inside	Outside
Center sphere	Cast Baritol	4966	0	3.130	0	3.940
First shell	Pressed Baritol	5911	3.134	4.360	3.944	5.480
Second shell	TNT	6844	4.364	5.340	5.484	6.600
Third shell	60% RDX + 40% TNT	7915	5.344	6.200	6.604	7.800

The plans of NWC China Lake to fabricate all the sections of the cylindrical fisheye lens charges from PBX with varying percentages of plastic binder (Ref. 6) had to be abandoned because of the inherent velocity of this explosive. The velocities of the five explosive compositions needed for the five sections of the cylindrical charge should increase progressively from the core to the outside cylinder and should lie between 4900 and 8000 m/s. Attempts to lower the detonation velocity of PBX below 6900 m/s were, however, unsuccessful; therefore it became evident that the center core and the first cylinder would have to be loaded with explosives other than PBX. Arrangements were subsequently made with the Chino plant of Aerojet-General Corporation to fabricate the first cylinder from Amatol and load the center void with Baritol. Table 2 shows the proposed explosive formulations, velocities, and dimensions of the five cylindrical sections for both the 6 in. and the 8 in. charges.

II. CURRENT WORK

SPHERICAL CHARGES

Pantex has sent to Sandia Corporation five spherical charges with 6.2 in. outside diameter and five with 7.8 in. diameter. Sandia Corporation has agreed to obtain complete pressure-impulse and velocity measurements at no cost to the Government (Ref. 7).

Five spherical charges of each size were also sent to the New Mexico Institute of Mining and Technology (NMT) to determine their damage-producing capabilities as compared with those of homogeneous charges

TABLE 2. Proposed Explosive Formulations, Detonation Velocities, and Dimensions of the Five Sections of the Cylindrical Charges. (Length-to-diameter = 1, 1.5, 2.)

Section	Explosive	Mixture	Velocity (m/s)	Diameter of Each Component (in.)			
				6 in. Charge		8 in. Charge	
				Inside	Outside	Inside	Outside
Center core	Baritol	67% $Ba(NO_3)_2$, 33% TNT	4966	0	3.000	0	3.900
First cylinder	Amatol	40% TNT, 60% NH_4NO_3	5900	3.004	4.200	3.904	5.800
Second cylinder	PBX	61% HMX, 39% Binder	6975[a]	4.204	4.900	5.804	6.400
Third cylinder	PBX	69% HMX, 31% Binder	7250	4.904	5.470	6.404	7.200
Fourth cylinder	PBXC-113	83% HMX, 17% Binder	8000	5.474	6.000	7.204	8.000

[a]This velocity is approximately 200 m/s too high for the second cylinder. Investigation is now under way to reduce this value.

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of the same size. Currently, one 6.2 in. charge and four 7.8 in. charges have been fired, as well as two spherical homogeneous charges for comparison. Figure 1 illustrates the "can-gage" arena at NMT and the positioning of the charges in relation to the arena. Figure 2 shows a spherical fisheye lens charge mounted for firing. The sphere was positioned with the booster and detonator at the bottom, so that upon detonation the focused products would be directed toward the gages. The charge holder was designed to eliminate interference with the focused output as much as possible.

Figure 3 shows the gas profile of a 7.8 in., 16 lb spherical fisheye charge at detonation, and Figure 4 shows the gas profile of a spherical homogeneous charge of the same size and weight. Comparison of the two photographs indicates that some focusing does occur from the wave-shaping effect of a spherical fisheye lens configuration.

In both the can-gage arena tests and the current tests with 1/2 in. thick steel witness plates, the focused mass products did not, however, produce as much damage as had been expected in the light of the damage achieved in some preliminary tests conducted by Dr. Conger in 1965 with a thin fisheye lens disk charge (Ref. 2). In those tests, a 3/4 lb thin disk charge 6 in. in diameter, 3/4 in. thick, and made up of five coaxial rings of explosive confined between two lucite plates (Figure 5) was fired at a 3/4 in. steel plate 2 ft from the side of the disk. A hole 2 in. in diameter was blown through the plate. In the current witness-plate tests, a 16 lb spherical fisheye lens charge was fired at a 3 × 5 in. steel plate, 1/2 in. thick, positioned 30 in. from the lens in the direction of aim. In this case the plate merely buckled slightly.

This anomaly has not been completely analyzed, but it is presently thought that the lesser energy level of the spherical charge as compared with the performance of the thin disk charge could be a function of (1) the differences in their geometries, and/or (2) the amount of confinement presented by the lucite plates of the disk. Dr. Conger is now conducting studies to determine whether the confinement of the explosives in the thin disk charge affected its output.

CYLINDRICAL CHARGES

NWC China Lake has surmounted initial difficulties encountered in casting PBX in cardboard molds, and is proceeding with the casting of the second, third, and outside shells for both sizes of cylindrical fisheye lens charges.

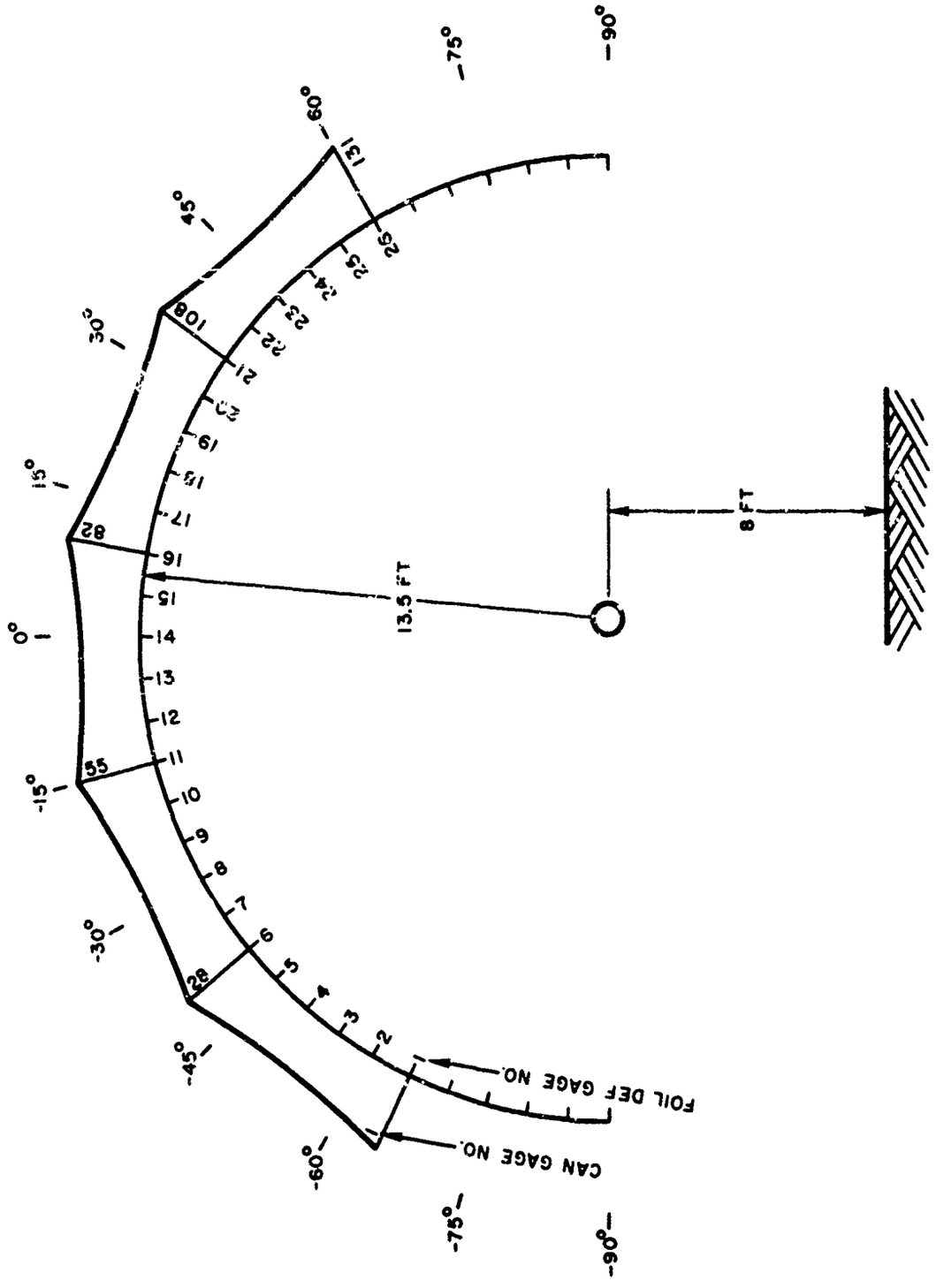

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FIGURE 1. Arena Setup at NMT for Testing the 6.2 and 7.8 in. Spherical Fisheye Charges

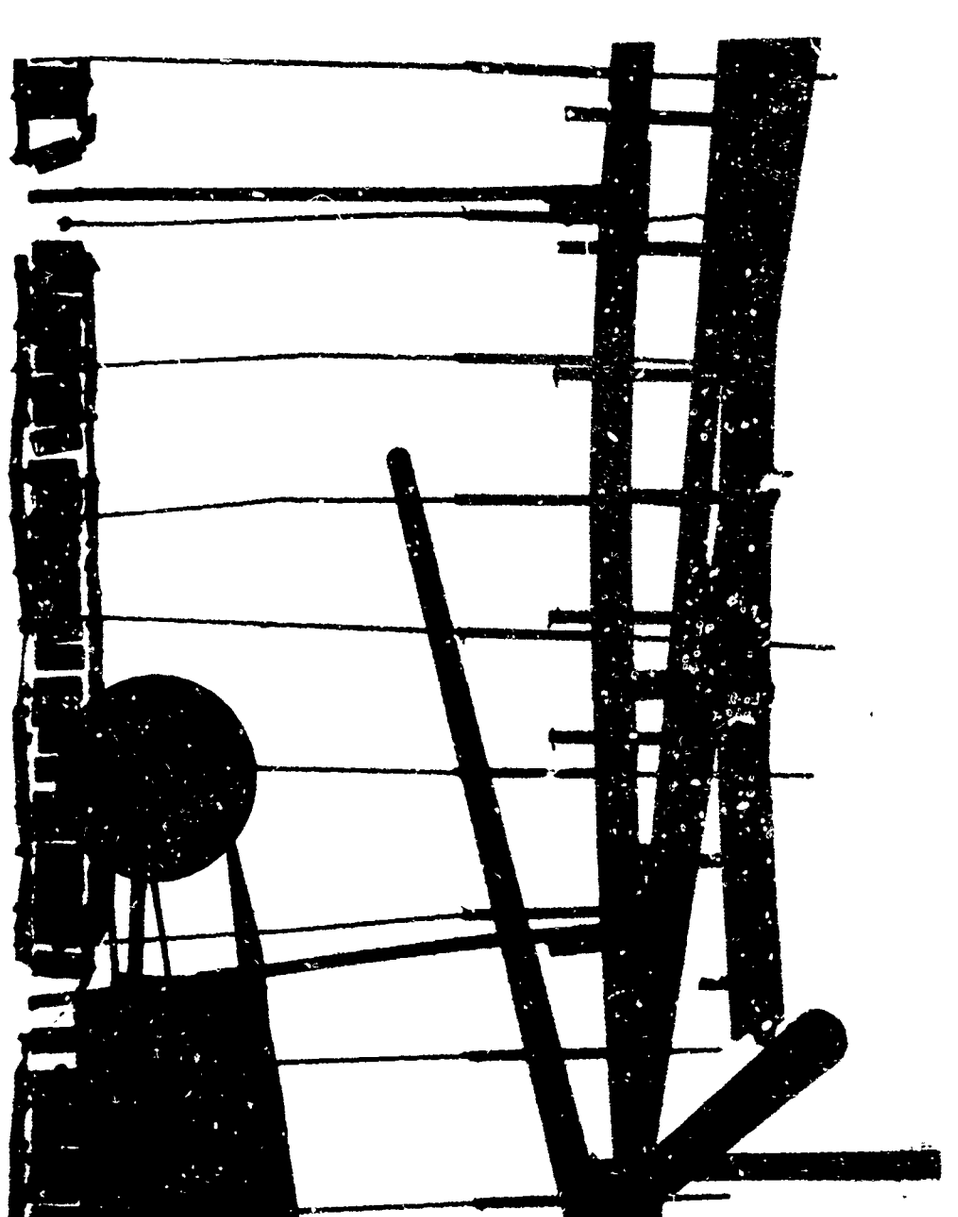

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FIGURE 2. Spherical Fisheye Lens in Position for Firing at the Can-Gage Arena

FIGURE 3. Gas Profile of 7.8 in. Diameter, 16 lb Spherical Fisheye Lens Charge at Detonation

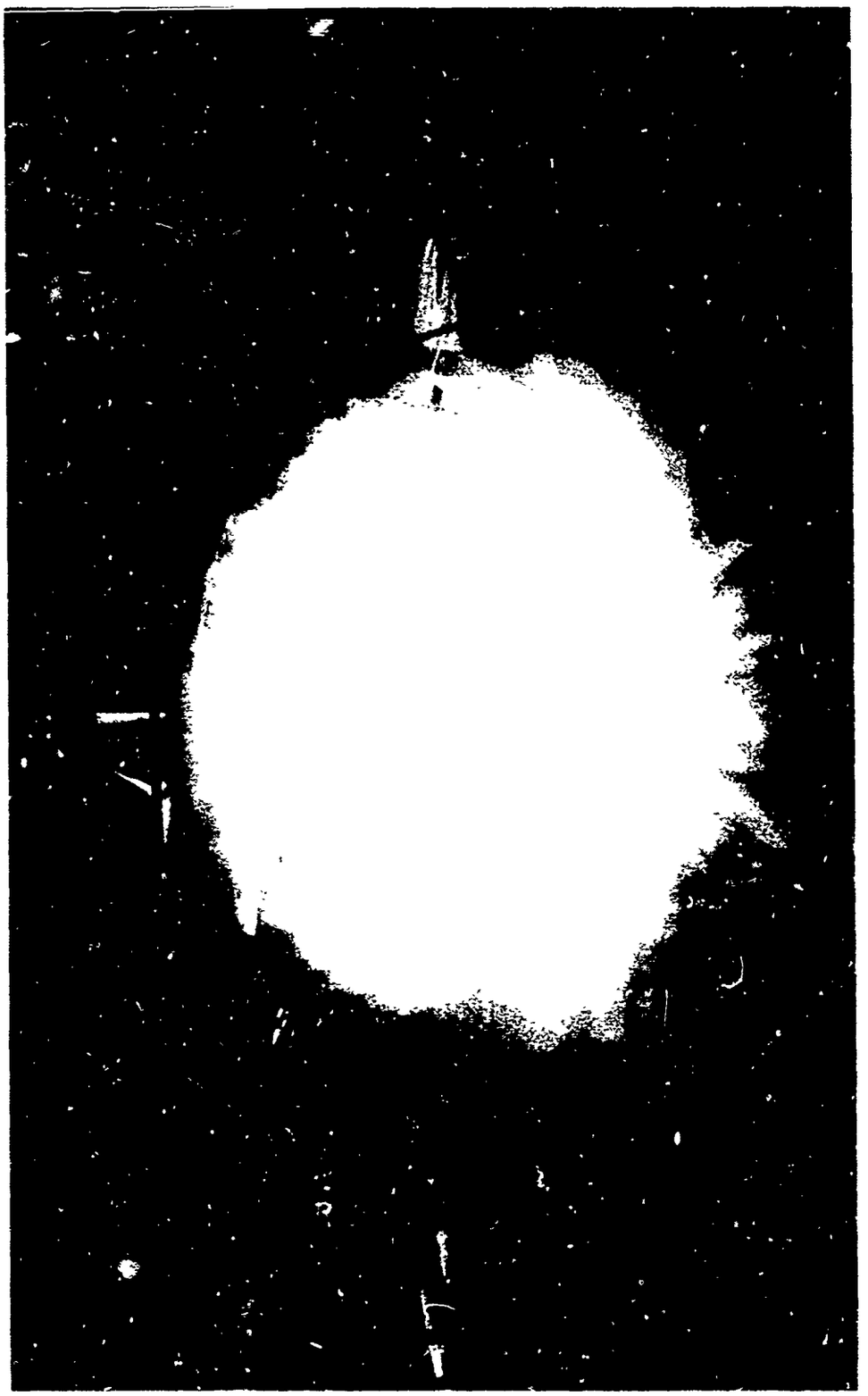

FIGURE 4. Gas Profile of 7.8 in. Diameter, 16 lb Homogeneous Charge at Detonation

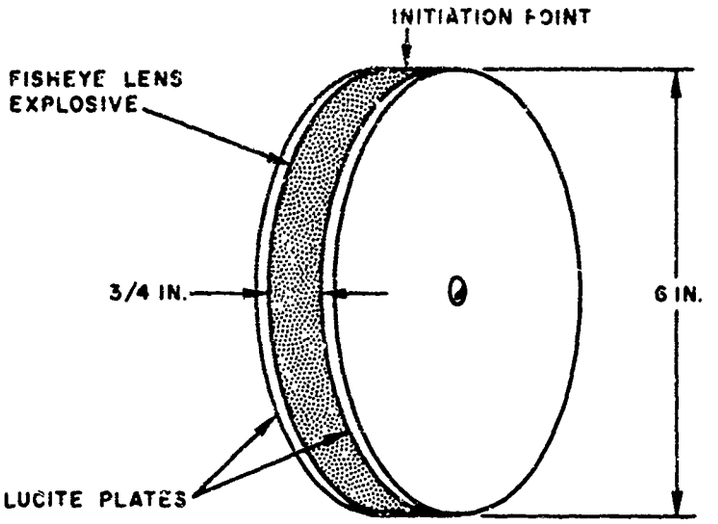

FIGURE 5. Thin Fisheye Lens Disk Fired in Preliminary Damage-Capability Tests

III. WORK PLANNED

SPHERICAL CHARGES

Within the next few weeks Sandia Corporation plans to fire 10 of the spherical fisheye lens charges. Flash X-ray photographic equipment will be used in their tests in an attempt to better understand the explosive mechanism of the fisheye charge. There are no immediate plans to continue firing at NMT.

CYLINDRICAL CHARGES

Within two or three weeks NWC China Lake expects to complete the PBX castings of the second, third, and fourth cylinders for 12 units; six assemblies will be 6 in. in outside diameter, and six, 8 in. These assemblies, in 24 in. lengths, will then be sent to the Chino plant of Aerojet, where the first cylinders will be fabricated of Amatol and the center voids will be filled with Baritol. When the loading is completed, the 24 in. lengths will be machined to length-to-diameter ratios of 1, 1-1/2, and 2, and samples will be tested to determine the degree of focusing attained for each length. The best configuration will then be

fired at NMT to determine its damage-producing capabilities as a function of standoff distance. The tentative test arena is diagramed in Figure 6. Side-on and overhead Fastax cameras will cover the tests to determine gas velocity, the degree of focusing, and the distance traversed by the expanding gases.

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5. NOLC Quarterly Report IED-B1, Warhead Studies: Explosive Lens Warhead (U), for the period ending 31 December 1965, by R. L. Higuera, Fuze Department, 1 March 1966. (Confidential)

6. NOLC Quarterly Report IED-B5, Warhead Studies: Explosive Lens Warhead (U), for the period ending 31 December 1966, by R. L. Higuera, Fuze Department, 31 January 1967. (Confidential)

7. NOLC Quarterly Report IED-B6, Warhead Studies: Explosive Lens Warhead (U), for the period ending 31 March 1967, by R. L. Higuera and F. L. Menz, Fuze Department, 31 May 1967. (Confidential)

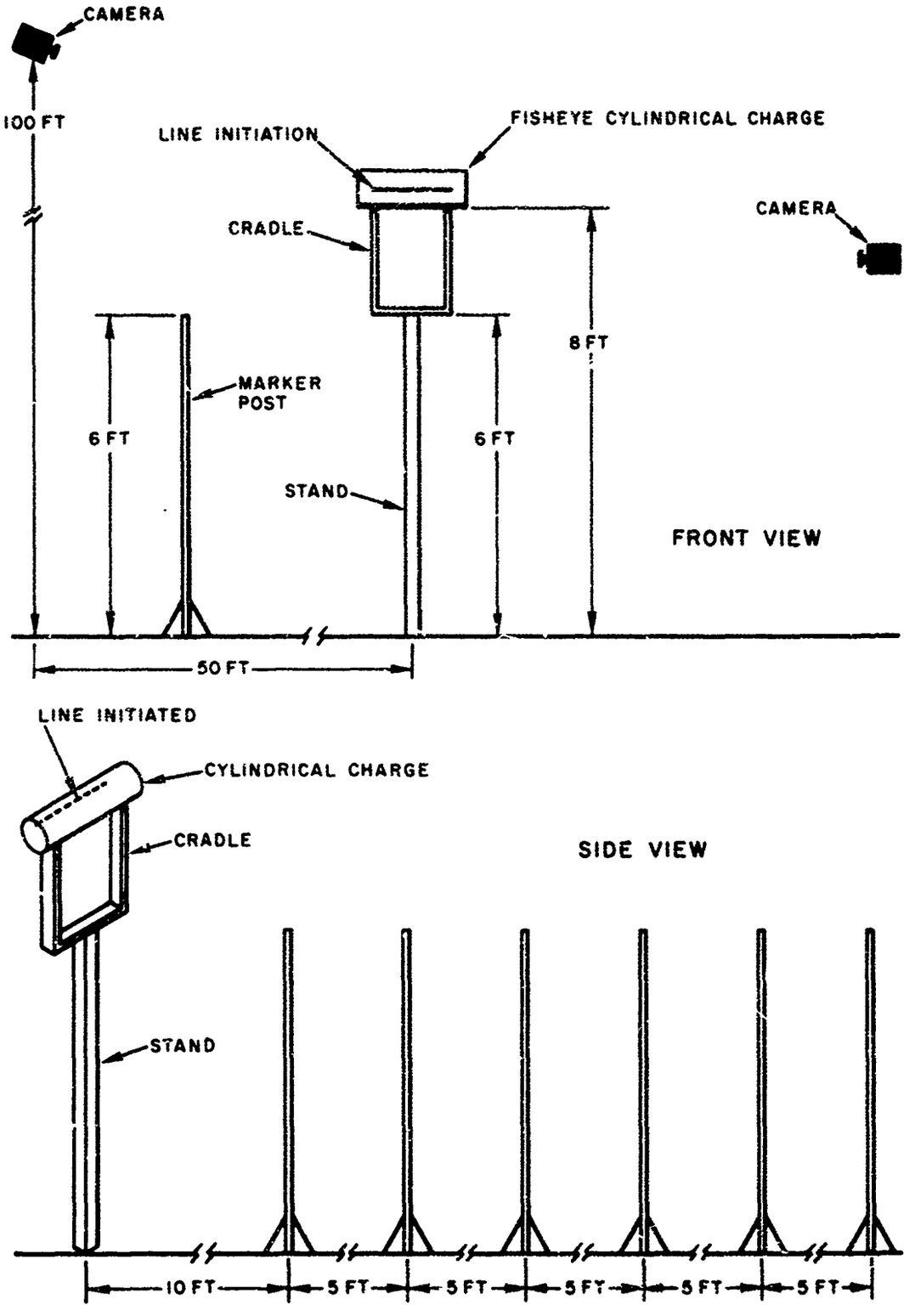

FIGURE 6. Setup for Testing Cylindrical Charges at Chino Arena

Security Classification UNCLASSIFIED

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY *(Corporate author)*

Naval Weapons Center Corona Laboratories
Corona, California

2a. REPORT SECURITY CLASSIFICATION

CONFIDENTIAL

2b. GROUP

4

3 REPORT TITLE

WARHEAD STUDIES: EXPLOSIVE LENS WARHEAD (U)

4 DESCRIPTIVE NOTES *(Type of report and inclusive dates)* Progress report on an independent exploratory development project for the quarter ending 30 June 1967

5 AUTHOR(S) *(First name, middle initial, last name)*

Richard L. Higuera
Fredric L. Menz

6 REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO OF REFS
28 July 1967	13	7

8a. CONTRACT OR GRANT NO	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO ZF009-98-01	IED-B7
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
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13 ABSTRACT

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Techniques for, and problems concerning, fabrication of cylindrical fisheye lens charges are discussed. (U)

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6801

UNCLASSIFIED
Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Warhead antiaircraft missile selectable-point initiation explosive charges aimable						

Naval Weapons Center Corona Laboratories. (Independent Exploratory Development Report IED-B7)

WARHEAD STUDIES: EXPLOSIVE LENS WARHEAD (U), Quarterly Report for the period ending 30 June 1967, by R. L. Higuera and F. L. Menz, Fuze Department. 28 July 1967. 13p. 6 figs. CONFIDENTIAL; DECLASSIFIED AFTER 12 YEARS

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2. Aimable warheads
I. Higuera, R. L.
II. Menz, F. L.
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(2) Date of Document: 1-4 March 1976
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(2) Date of Document: 2 Dec 1974
(3) DTIC AD Number:ADD513479
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i. WARHEAD STUDIES: EXPLOSIVES LENS WARHEAD QUARTERLY PROGRESS REPORT FOR THE PERIOD ENDING 30 JUN 67 (U)
(1) Author/s: Higuera, Richard L. and Menz, Fredic L
(2) Date of Document: 28 Jul 1967
(3) DTIC AD Number:AD0383490
(4) Authority: Approved for public release: NAWC 03-159
(5) Date of Change: 17 Nov 2003
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j. HYBRID MECHANICAL-ELECTRONIC SAFTY-ARMING DEVICE AND ITS APPLICATION TO A BOOSTED MODULAR WEAPON FUZE (U)
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(2) Date of Document: January 1975
(3) DTIC AD Number:ADC001117
(4) Authority: Associated Marking Instruction
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k. POLYNITROPOLYAZA CAGED EXPLOSIVES PART 6 (U)
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(4) Authority: OPNAVINST 5513.3B (25)
(5) Date of Change: 21 Dec 1995
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m. INTEGRAL ROCKET-RAMJET COLD-GAS PORT COVER BLOW-IN FACILITY (U)
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